STRIP CROPPING for War Production

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IN THE NATION'S effort to produce adequate quantities of all agricultural products to meet the war needs of the United Nations, conservation assumes added importance. Advancements in the management of croplands to conserve soil and moisture, which have come about in recent years as a result of experimentation and the experiences of many farmers, show that conservation increases crop yields. Strip cropping is one of the conservation practices. In its various forms and patterns, it is applicable to a large area of the United States.

With the farmer rests the major responsibility of obtaining conservation on the land. Each farmer should examine for himself the need of strip cropping his cultivated land and in doing so should find the information contained in this bulletin helpful. The kinds of strip cropping, the factors influencing their use, methods of application, value in conserving soil and moisture, and the adaptation of strip cropping to the northeastern and north-central, the southeastern and western Gulf, the Great Plains, and the far Western States are discussed. Additional information may be obtained from State experiment-station and extension-service publications.

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STRIP CROPPING FOR WAR PRODUCTION[1]

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INTRODUCTION

SUSTAINED high production of food and fiber is one of the essential requirements of the United States at war. Top production for 1 year, or 2 years is not enough. It must be continued and maintained for the duration of the conflict—and for years afterward. To do this, America's farm production plant must be kept in the best possible productive order. Farming practices that contribute to this farm-plant maintenance are tools of war, just as much as precision machinery in war-industry plants are tools of war.

Such a farming practice is strip cropping, for it not only helps to maintain the physical productivity of the farm plant but also tends to increase the yields per acre of farm commodities. Strip cropping, in short, is a war tool of the farmer in the performance of his war work; production of Food for Freedom.

To be quite accurate, strip cropping is not a single practice; it is a combination of good farming practices. Strip cropping employs crop rotations, contour cultivation, proper tillage, stubble mulching, cover cropping, and other practices. The strip-cropping system maintains soil fertility and often increases it, provides for the growing of field crops in a systematic arrangement of strips or bands which serve as vegetative barriers to erosion and waste of soil, water, and fertilizer. These are the principal and clearest advantages of the practice—or system.

The principal disadvantage of the system is its newness to many American farmers. Yet strip cropping is not new. It is likely that it was first practiced in Europe; however, little is known regarding how and where it originated. Frederic Seebohm, in his book "The

[1] Acknowledgment is made to field men of the Soil Conservation Service and other agricultural agencies for suggestions, information, and assistance contributed in the preparation of this bulletin; and to farmers who are responsible for improvements in the methods of application and use of strip cropping.

English Village Community," published in 1883, states that strips were common to open fields all over England, sometimes separated by hedges and sometimes by balks of unplowed turf. In hilly districts, the strips were made to run horizontally along the hill instead of up and down hill. They were plowed one way throwing the furrow downhill, which in effect developed bench terraces. The strips in England might have started 600 years before because of a law establishing the dimensions of a statute acre. The author further states that in Bavaria the shape of strips in open fields has been set by law 400 feet long and 40 feet wide for more than a thousand years.

Farmers in the steep, rolling sections of Pennsylvania, Ohio, West Virginia, and Wisconsin have been strip cropping for the control of water erosion for 50 years or more. F. H. King, in a University of Wisconsin Experiment Station bulletin, published in 1894, recommended the planting of crops north and south in long, narrow bands 15 to 20 rods wide, alternating with similar strips of grass for the control of wind erosion on the Plainfield sand areas in Waushara, Portage, and Waupaca Counties. In 1913, W. M. Jardine, of the Kansas Experiment Station, in writing of the control of wind erosion in northwestern Kansas, mentioned the need of farming in strips.

The first general use of strip cropping for wind-erosion control seems to have been in the Monarch District, of Alberta, Canada, where farmers have been strip cropping for more than 20 years. They had observed that a growing crop or stubble gave protection to adjoining land in fallow. So the idea of dividing their fields into strips of grain and summer fallow was conceived. Later, the practice was adopted by farmers in Montana and other wind-erosion areas in the West and Southwest.

Since 1933 the Soil Conservation Service has established more than 175 demonstration projects to try various methods of controlling wind and water erosion. Strip cropping proved its value and now Service conservationists are assisting farmers in soil conservation districts throughout the United States in the planning and establishment of this and other conservation practices.

KINDS AND USE OF STRIP CROPPING

Four general types of strip cropping are recognized: (1) Contour strip cropping, (2) field strip cropping, (3) wind strip cropping, and (4) buffer strip cropping.

(1) In contour strip cropping, the crops are arranged in strips or bands on the contour at right angles to the natural slope of the land. Usually the strips are cropped in a definite rotational sequence, although all of the crops in the rotation need not be in the same field or field unit in the same year. This type of strip cropping is used generally for the control of water erosion; however, it is also used effectively on sloping land in areas where wind erosion may be as serious as water erosion (fig. 1).

(2) In field strip cropping, the strips are of uniform width and are placed across the general slope but do not curve to conform to any contour. It is recommended only in areas where the topography is too irregular or undulating to make contour strip cropping practical (fig. 2).

FIGURE 1.—Contour strip cropping in three fields of a Wisconsin farm.

(3) In wind strip cropping, the strips are uniform in width, usually straight and laid out across the direction of the prevailing winds. It is recommended on level or nearly level land where erosion by water is unimportant (fig. 3).

(4) In buffer strip cropping, strips of some grass or legume crops are laid out between strips of crops in the regular rotations. The

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FIGURE 2.—Field strip cropping on a Pennsylvania farm.

FIGURE 3.—Wind strip cropping on a North Dakota farm. Strips are even width, parallel, and crosswise to the direction of prevailing winds.

strips may be wide or narrow and of even or variable widths. They may be placed only on steep, badly eroded areas of a slope, or they may be at more or less regular intervals on the slope. Usually only one of the crops of the rotation is planted in a field; in other words,

FIGURE 4.—A buffer strip of bluegrass and timothy between tobacco and corn on a Kentucky farm.

as many fields or field units are provided as there are crop units in the rotation. The buffer strips are used to give more protection from erosion than is afforded by a solid planting of grain or intertilled crops. Where the buffer strips are on the contour, they facilitate contour tillage. For wind erosion, some annual crop may be used in the buffer strip (figs. 4 and 5).

The kind of strip cropping to be used depends on a number of local conditions, such as the kinds of crops that can be grown, the kind of erosion (wind or water), and the physical characteristics of the soil.

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FIGURE 5.—Buffer strips of corn in a potato field on a farm in North Dakota for protection against wind erosion.

FACTORS INFLUENCING THE USE OF STRIP CROPPING

CLASSES OF LAND

A consideration of the land on the farm from the standpoint of its use capability—that is, its suitability for use as a cropland, pasture, or woods—and the intensity of practices required to conserve soil and moisture on the land that is suitable for cultivation aids in determining the need for and the kind of strip cropping to use. Soil characteristics, slope, degree of past erosion, and climate determine the relative use capability of land. Classes of land within a use-capability group, for example, classes of land suitable for cultivation, are determined on the basis of the intensity, or number, of practices required to conserve soil and moisture and maintain productivity.

Farmers in soil conservation districts are becoming familiar with the description of the eight classes of land according to use capability, the first three, cropland; the fourth, primarily pasture or hay

land with only limited crop production; the next three, permanent vegetation; and the eighth, land unsuited for agricultural use other than wildlife. Strip cropping applies primarily to cropland and particularly to land in classes II and III. Class I land is fairly level, of moderate to high productivity, and subject only to slight erosion. Such land does not require special erosion-control practices such as strip cropping. Class II land is also moderate to high in productivity but may be somewhat sloping and subject to erosion. Here strip cropping materially assists in the control of erosion and in increasing crop yields. Class III land presents the most difficult problems. Slopes may be steep and badly eroded, yields may be low owing to low fertility and lack of organic matter, or too-low rainfall, and the land may be subject to both wind and water erosion. On such land, all the adapted soil-building measures and soil conservation practices should be used. Where applicable, strip cropping on class III land is one of the most effective conservation practices because it facilitates the employment of soil management and other conservation practices. Class IV land is primarily suited for use as pasture or hay land, the soil being too shallow, the slopes too steep, the rainfall too low, or other conditions exist which make it unsuited for use as cultivated land. Under some conditions, to maintain most productive pasture or hay stands, however, an occasional plowing and reseeding may be necessary. Frequently, when renewing stands in this manner, it is desirable to crop the land a year or two to a row crop or small grain. It is always advisable that plowing and cropping on class IV land be done in strips to avoid exposing the entire slope or area to erosion at one time.

FIELD ARRANGEMENT

After the land use has been determined for the farm and the cropland has been outlined, one of the first things to decide is the most convenient field arrangement. Existing fences may need to be removed and new field boundaries established to give the best arrangement of fields for strip cropping. In determining the number of fields or field units, consideration should be given to the crop rotation. Often the capability of the land, the livestock feed requirements, and the kind of erosion, are the deciding factors in the selection of the crop rotation. As soon as the crop rotation is decided on, the number, size, width, and arrangement of strips can be worked out so as to secure a crop balance and sufficient roughage for summer grazing and winter hay. When all this is done properly, the strip-cropping system provides a definite plan for the sequence of crops. When this plan is not followed, the strip-cropping system has to be altered, and its effectiveness in the conservation of soil and moisture is reduced.

ROTATIONS

Too much emphasis cannot be placed on the importance of the rotation in the strip-cropping system both in regard to the crops and the crop arrangement within the rotation itself and also within the field or field unit. Rotations which provide strips of close-growing perennial grasses and legumes alternating with an intertilled crop or a grain crop is the most effective arrangement of crops for the reduction of erosion on cropland Such an arrangement of crops can

be obtained by using a 4-year rotation—an intertilled crop, small grain, and 2 years of meadow; a 5-year rotation—an intertilled crop, small grain, and 3 years of meadow; and a 6-year rotation—an intertilled crop, a grain crop, and 4 years of meadow. To get the proper crop arrangement in fields, two field units are necessary for the 4-year rotation and three field units for the 5- and 6-year rotations. In any of these three rotations one field unit will have alternating strips of intertilled crop and meadow, while a second unit will have alternating strips of grain and meadow, and the third unit, in the cases of the 5- and 6-year rotations, will all be in meadow. These cropping arrangements are described in detail on pages 22 to 29.

In sections of the country where perennial grasses and legumes are not widely adapted, a rotation of intertilled, small-grain, and annual legume crops can be arranged in strips. The sequence of crops should be arranged so that maximum use can be made of winter and summer cover crops, green-manure crops, and crop residues to protect and improve the land. In dry-farming areas, the sequence of intertilled and small grain crops, and fallow if used, should provide for efficient use of moisture and for adequate crop residues.

CONTOUR TILLAGE AND TERRACES

Tillage operations, such as plowing, disking, harrowing, planting, and cultivating, can be done on the contour without strip cropping, but it is usually more difficult because there are no permanent markings to follow. A strip-cropping system provides definite contour guide lines for each farming operation. Additional protection against water erosion can be obtained by the use of terraces. Terraces are especially needed with strip cropping on fields having numerous small depressions, or gullies, where runoff concentrates. Diversion terraces may frequently be used to advantage in place of regularly spaced terraces where slopes are too steep or irregular for the latter. They may also be used to protect strip-cropped fields against runoff from higher lying lands. Level, closed-end terraces are needed with strip cropping in many dry-farming areas to prevent runoff and increase crop yields. Where terraces are used with strip cropping to prevent runoff and erosion, more intertilled crops may be grown in the rotation.

LIMING, FERTILIZING, AND MANURING

The effectiveness of strip cropping in humid regions depends much on the quality of the meadow strips. Vigorous, dense stands of the perennial meadow grasses and legumes are required to control erosion, improve the soil, and increase yields. In order to get the rotation started, to promote vigorous, dense stands of the perennial grasses and legumes, and to increase yields, lime and fertilizer should be applied according to needs. Strip cropping provides an orderly plan whereby each strip can be limed or fertilized in regular order; the expense can be budgeted evenly over a period of years; and because of the protection afforded by the strip-cropping system, little or none of the materials is lost by erosion.

Under many conditions, strip-cropping facilitates the use of soil-management practices to maintain or build organic matter in the soil.

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Rotations are selected which include a combination of deep-rooted and fibrous-rooted crops a large proportion of the time. Crop residues are left on the ground or returned in the form of manure in regular order because of the systematic rotation used in strip cropping. Green manure or cover crops are often grown between or in combination with the regular crops in the rotation.

TILLAGE AND CROP-RESIDUE UTILIZATION

Tillage that leaves the surface of the soil cloddy and mulched with crop residues, is effective with strip cropping to prevent soil washing and drifting, and to conserve moisture. It is one of the most effective measures to conserve soil and moisture on land that is in fallow and to protect small-grain and row-crop land during periods of seedbed preparation for a succeeding crop. A combination of these two practices will provide greater protection against erosion than either practice alone. In the control of wind erosion, strip cropping aids by reducing the expanse of individual clean-tilled areas and by reducing the velocity of the wind at the surface of the ground: while tillage, leaving the surface cloddy and mulched with crop residues, conserves moisture and lessens the tendency of the soil to drift. Frequently, soil will start drifting from an exposed knoll, sandy spot, or bare area in a field. Strip cropping confines the drifting to one strip where it may be brought under control by tillage or other means more easily than had it spread to the entire field.

In one sense, a strip-cropping system for both wind- and water-erosion control, in both humid and dry-land areas, may be considered as a combination of conservation and soil-improving practices. It may safely be said that strip cropping is only as effective as the rotation and the other soil-improving practices used with it.

METHODS OF LAYING OUT CONTOUR STRIP CROPPING

There are many ways of laying out contour strip cropping. Three general methods are discussed: (1) Both edges of the strips on the contour; (2) one or more even width strips laid out from a key or base contour line; (3) alternate, even and irregular width strips. But, regardless of the method used, one or more contour lines must be laid out on each field to be strip cropped. A contour line is simply a level line across a slope. With a little experience in the use of a level, it is easy to survey and stake contour lines. For this work, some kind of a level is needed. A surveyor's level, a farm level, an inexpensive hand level, or even a carpenter's level, may be used with satisfactory results.

In laying out a strip-cropping system in a field, it is first necessary to know how to survey contour lines, and next, to know where they should be staked on the slope, since the strips are located in the field in relation to contour lines. This is where different operators have different approaches. Some start in the middle of the slope and lay out as many of the longest strips possible, leaving the odds and ends of the field to work themselves out at both the top and bottom of the field. Some start at the top of the field and lay out one strip after another down the slope. Some reverse the procedure and start at the bottom of the field. There is no set rule. The general topog-

raphy of the land and the way the operator has adapted this practice will be the determining factors.

When the strip-cropping system is laid out so that both the upper and lower edges of the strips are on the contour, all strips are irregular in width (fig. 6). On fairly uniform slopes, the width of the strips is fairly uniform, but where the degree of slope varies widely, the width of strips is more irregular. Strips are narrow in width where the slope is steep and wide where the slope is flat. Uneven-width strips necessitate the use of point rows, but all farming operations are on the contour, which is most effective in preventing runoff and soil losses. Some farmers prefer to plant the point areas to perennial hay crops, or the year the strips are planted to intertilled crops, to a close-growing annual crop to eliminate some of the point rows. Since the point-row areas occur on the flatter portions of the slope where the soil is usually best, most farmers prefer to plant the point-row areas to the regular crops in the rotation.

When the difference in the width of strips varies too much, operators may prefer using some even-width strips, the second method. One or more even-width strips may be laid out from one key or base contour with an irregular-width strip between each set of even-width strips. The irregular-width strips are called correction strips and may be used as buffer strips or may be used in the regular rotation. This method provides some even-width strips for farming without point rows, but all farming operations are not on a true contour (fig. 7).

The third method provides for alternate strips of even and of irregular widths. From the first contour line, which can be staked from any point in the field, an even-width strip is measured out

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FIGURE 6.—Contour strip cropping with alfalfa-meadow strips between corn and oat strips on 10- to 12-percent slopes on a farm in Minnesota. Both edges of the strips are on the contour.

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FIGURE 7.—Irregular strips between sets of even-width strips on a farm in Ohio.

above the contour line. The second contour line is staked at a distance equal approximately to the width of two strips either above or below the first contour line. An even-width strip is then measured out above this second contour line. This process is repeated until

MONT-38

FIGURE 8.—Alternate even- and irregular-width strips on a farm in Montana.

the entire field has been laid out in a strip-cropping system. When this method is used, each contour line forms the lower boundary of an even-width strip and the upper boundary of the adjoining irregular-width strip. Where fields are large—160 acres or more—contour maps have been found helpful in laying out contour strip-cropping systems. By this method, uniform-width strips for cultivation separated by irregular-width strips to be seeded to perennial grasses are located on the map in relation to the contour lines and soils. Minor variations are often made in the location of the strips in relation to the contour lines so that a minimum of land is devoted to the correction area, and so that the correction areas are located on the poorer land (fig. 8).

Because of modification in methods due to local conditions, it is always advisable to obtain the assistance of someone who has had experience in laying out contour strip-cropping systems. The effectiveness of strip cropping depends on how closely the strips follow the contour, and the convenience of farming depends on the length and shape of the strips. Many of the States have published bulletins that explain methods of laying out strip-cropping systems for local conditions. These can be obtained from the Extension Service.

LAYING OUT WIND STRIP CROPPING, FIELD STRIP CROPPING, AND BUFFER STRIP CROPPING

In wind strip cropping, the strips are laid crosswise to the direction of the prevailing winds, even in width and parallel. The strip boundaries are usually marked by stakes in the fence rows. Strips should be of the proper width to assure efficient use of the farm equipment. Similarly, in field strip cropping, the strips are laid crosswise to the general slope, even in width and parallel. The location of buffer strips is determined largely by the width and the arrangement of adjoining strips to be cropped in rotation, and by the location of steep, badly eroded areas on slopes. On sloping land, buffer strips usually include the correction areas.

WIDTH OF STRIPS

There is no rule for determining the width of strips in a strip-cropping system that will apply under all sets of conditions. In the humid regions, strips from 60 to 150 feet in width are in use. The degree and length of slope, the permeability of soil, the susceptibility to erosion, the amount and intensity of rainfall, kinds and arrangement of crops in the rotation, and the size of farm equipment, are some of the factors that influence the width of strips. In the dry-farming regions for wind-erosion control, strips of peanuts as narrow as 12 feet and strips of small grain as wide as 320 feet are in use. Under the different soil-drifting conditions, farmers have learned by experience that the width of strip may vary depending on the type of soil, the cropping and tillage system, and the wind velocities. Where protection is needed from both wind and water erosion, the maximum width of strip should not exceed the safe limits of width for either type. Actual field trials will provide the most accurate information.

Terraces have the effect of shortening the slope, that is, the length of slope is measured by the distance between the terraces rather than by the entire distance up and down the field. For this reason, terraces,

when used with a strip-cropping system, influence the width of strips. In some cases the width of strips will be the same as the distance between the terraces. Under other conditions, it may be advisable to make the strip wide enough to include more than one terrace interval.

In general, strips should be made a width most convenient to farm, yet not so wide as to permit concentration of runoff and excessive soil losses. It has been found that more soil and water losses may occur by having the strips too far off the contour than by having the strips of intertilled crop too wide. On uneven slopes where strips do not follow the contour closely, they may need to be narrower, to prevent erosion, than strips on uniform slopes with only slight variations from the contour.

GRASSED WATERWAYS

Waterways are usually essential with a strip-cropping system. They should be protected by a grass sod or other suitable close-growing vegetation. When the field is laid out for strip cropping, definite plans should be made for seeding or sodding all major waterways. If the field is in meadow when strip cropping is started, the waterways should be left in sod.

It is usually best to seed or sod the waterways at the same time meadow seedings are made in the field, but they can be prepared and seeded separately. When the waterway is badly eroded or gullied, it may be necessary to level it somewhat with a disk, plow, or grader before preparing the seedbed. A hay or straw mulch will protect the seeding until the grass is established. Later it may be necessary to place pieces of sod in spots where the new seeding or sodding has been washed out in spite of all precautions.

FIGURE 9.—Broad grassed waterway on an Illinois farm.

It is a common mistake to make grassed waterways to narrow. They should be made wide enough to mow and should be clipped at the time meadow strips are cut for hay (fig. 9).

HEADLANDS AND FIELD BORDERS

Headlands, or turnrows, and field borders should be kept in sod. In many parts of the country, it is customary to cultivate the ends of crop fields, often planting four or more rows of intertilled crops or drilling small grain at right angles to the regular field planting. Since the ends of fields cannot be tilled on the contour, serious erosion may occur. Instead of farming headlands, it is advisable to seed them with perennial grasses and legumes and let them remain in sod permanently. They provide a place to turn with equipment and move

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FIGURE 10.—Field border planted to sericea lespedeza on a South Carolina farm.

from one strip to another. They can be mowed with the meadow strips and grassed waterways.

In some dry-farming areas, the ends of strips are rounded (fig. 7) to eliminate the need of using headlands for turning farm equipment, and thereby creating an erosion hazard. With round-end strips, the headland seeding should conform to the shape of the rounded ends of the strips to avoid having idle areas where weeds may grow.

Often field borders parallel hedge rows or woods where production of crops is low because of shading and moisture competition (fig. 10). Such areas are of more value planted to vegetation that provides food and cover for wildlife, at the same time protecting the area from erosion, than they are for the production of field crops. In wind-erosion areas where well-adapted perennial grasses and legumes are not available for headland and border plantings, close-drilled sorghum or Sudan grass may be used (fig. 11).

TEX-15133

FIGURE 11.—Field border and headland planted to Sudan grass on a Texas farm.

MANAGEMENT OF STRIP-CROPPED FIELDS

When the strip-cropping system has been carefully planned and accurately laid out in the field, it can be readily maintained permanently by proper management. In general, farming operations are no different for farming strips than for farming whole fields; yet some extra precautions are necessary.

The crop rotation should be maintained. Meadows should be plowed and planted to the proper crops according to plan. If meadow seedings fail on one series of strips, they should be reseeded so as not to interfere with the sequence of crops in the strip-cropping system.

The plowing of strips should be varied so as not to build up high ridges on the edges and deep dead furrows in the centers. The equipment used and the shape and the location of the strips may determine how the strips should be plowed. If a two-way turning plow is used, land can all be turned up the slope so that water can seep under the furrow slice. After a little experience, strips can be plowed as easily as ordinary plowlands.

When planting contour strips of uniform width, start at either the top or bottom side and continue across the entire width of the strip. Where the strips are irregular in width and both sides are on the contour, most farmers prefer to plant from both sides toward the center. This places the greatest number of rows on the contour with the point rows all in the center of the strip and is the most effective row arrangement to conserve moisture. Also, many farmers feel such a planting arrangement (1) saves time by eliminating long deadhead trips in cultivating and harvesting long and short rows together and (2) is more convenient, especially when harvesting row crops. Corn can be cut for silage or husked, by hand or with machinery, by starting on the long outside rows, leaving the short point rows to be

FIGURE 12.—Planting from the outside edges toward the middle puts all point rows in the center of the contour strip.

harvested last and eliminating the need of turning on the crops of adjoining strips (fig. 12).

The grassed waterways should be protected from all tillage operations. Plows should be raised out of the ground, disk harrows should

FIGURE 13.—Lifting the plow when crossing the waterways.

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be straightened, and cultivators should be lifted before crossing a grassed waterway.

Grassed waterways have a tendency to build up with sediment. In extreme cases, the location of the waterway may be shifted to such an extent that the water flows along the edges, often starting new gullies. For this reason, the edges of a grassed waterway should be left irregular. A little care in crossing waterways with tillage implements, avoiding plowing furrows parallel to the waterway, allowing the grassed waterway to widen as the need arises, mowing to prevent excess accumulation of forage, and protection from being trampled by livestock when the ground is wet and soft will assure permanent, efficient waterways for the removal of runoff from rains of high intensity (fig. 13).

VALUE OF STRIP CROPPING

The best evidence of the value of strip cropping comes from the farmers who have adopted it. On the Soil Conservation Service demonstration approximately 4,000,000 acres have been planned for strip cropping. In the 4 years since the start of soil conservation districts, the farmers themselves have planned another 1,000,000 acres of strip cropping, of which more than 700,000 acres have been put into operation. Such figures indicate a general acceptance of this conservation practice by farmers.

There are a number of reasons for this increased acreage of strip cropping. Farmers see a conservation of moisture and a reduction of water runoff which results (1) in a decrease in the loss of topsoil, with its lime, fertilizer, and soil organic matter, and (2) in an increase in crop yields. With the effort made by the Department of Agriculture to adjust production in accordance with supply and demand, this practice enables farmers to produce adequately at a lower cost. Production can be maintained on fewer acres. This gives farmers an opportunity to crop their land in accordance with its use capability. Land that is badly eroded, is steep, or has obstacles that hinder cultivation, can be converted to permanent vegetation as pasture, hay, or woodland.

CONSERVATION OF MOISTURE AND SOIL

In contour strip cropping all tillage and seeding operations are on the contour, and every implement furrow and crop row serves as a miniature dam or terrace to retard runoff. The effectiveness of contour cultivation in preventing runoff is shown in table 1. These figures show a marked reduction in both soil and water losses due to contour cultivation. Strip cropping, except wind strip cropping, provides for all tillage and seeding operations to be on the contour.

When the topsoil is allowed to wash away from the higher parts of the field, it is deposited on the lower flatter areas. Sometimes soil washing and deposition take place within the same field, and sometimes they take place from one field to a neighboring field. Such a process may destroy crops in one area by washing them out and in another area by covering them with silt (fig. 14). In either case yields are reduced. Likewise, when soil drifting occurs, plants may be weakened or killed by the abrasive action of the soil particles, by the removal of soil from around the plant roots, and

by smothering of the plants with drift soil. Use of the land may be lost for a year, or reseeding may be necessary, in which case the yield may be lower.

TABLE 1.—*Comparison of soil and water losses from different soils when farmed on the contour and up and down hill. (Data from soil and water conservation experiment stations, Soil Conservation Service)*

Soil and location	Slope	Treatment	Row direction	Soil loss per acre	Water loss as compared with precipitation
	Percent			*Tons*	*Percent*
Houston Black clay, Temple, Tex., 1931–40.	4	Rotation: Corn-oats-cotton.	Contour	4.3	5.0
			Up and down hill	11.1	8.3
Vernon fine sandy loam, Guthrie, Okla., 1932–35.	6.8	Cotton (wheat winter cover).	Contour	24.6	9.9
			Up and down hill	55.2	11.1
Colby silt loam, Hays, Kans., 1934–38.	4.5	Wheat	Contour	1.5	9.8
			Up and down hill	2.1	13.0
	4	Kafir	Contour	.7	2.6
			Up and down hill	13.6	20.4
Houston Black clay, Temple, Tex., 1932–41.	3.5	Cotton	Contour	5.9	4.6
			Up and down hill	15.7	13.6
Muskingum silt loam, Zanesville, Ohio, 1939–40.	12	Corn	Contour	15.4	4.1
			Up and down hill	57.3	6.8
Marshall silt loam, Clarinda, Iowa, 1933–37.	8	do	Contour	7.3	1.8
			Up and down hill	27.7	10.2

While such crop damage from soil washing and soil drifting reduces yields, the more serious losses are incurred by the loss of topsoil and the covering of topsoil with unproductive subsoil, sand, or gravel.

Carefully conducted experiments show that water and soil losses are less from meadow crops than from either grain or intertilled crops. Also, that losses are much less from rotations than from continuous

FIGURE 14.—Up-and-down-hill farming results in a loss of topsoil and moisture and damages growing crops.

cropping. The denser a crop grows and the longer it occupies the ground, the lower the water and soil losses. For example, corn, cotton, tobacco, beans, potatoes, and other intertilled crops, and also buckwheat and soybeans, occupy the land only during the summer and do not provide a dense cover nor a root system to give much protection to the soil. Row crops, such as corn and sorghum, however, may provide good protection against wind erosion. Small grains may occupy the land an even shorter time, but they provide a denser ground cover, a greater total root system, and more dense residues than row crops; they therefore provide more erosion protection. Perennial grasses and legumes occupy the land the entire year, have a very dense top growth during the summer months, and a deep fibrous root system producing a dense sod, which provides the greatest erosion protection.

Soil and water losses from row crops, small grain and meadow crops grown in rotation, and the average for the rotations at several soil and water conservation experiment stations, are shown in table 2.

TABLE 2.—*Annual soil and water losses from row crops, small-grain and meadow crops grown in rotations, and the average for the rotation of crops. (Soil and water conservation experiment stations, of Soil Conservation Service* [1])

Location, slope, and period	Cotton		Corn		Small grain		Meadow crops		Average of rotation	
	Soil loss per acre	Water loss as compared with precipitation	Soil loss per acre	Water loss as compared with precipitation	Soil loss per acre	Water loss as compared with precipitation	Soil loss per acre	Water loss as compared with precipitation	Soil loss per acre	Water loss as compared with precipitation
	Tons	*Percent*	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*	*Percent*	*Tons*	*Percent*
Zanesville, Ohio, 12 percent slope, 1934–40	-------	-------	42.7	24.8	9.8	25.8	[2] 0.35	[2] 17.2	13.3	21.2
Bethany, Mo., 8 percent slope, 1931–40	-------	-------	18.8	19.7	7.3	18.5	1.1	10.4	9.1	16.2
LaCrosse, Wis., 16 percent slope, 1933–38	-------	-------	53.1	20.6	30.0	18.8	.9	11.2	28.0	16.9
Guthrie, Okla., 7 percent slope, 1930–38	10.6	11.3	-------	-------	1.4	12.4	.5	6.8	4.2	10.2
Statesville, N. C., 10 percent slope, 1932–38	23.2	9.9	30.2	10.3	5.6	13.1	1.6	3.9	15.1	9.3

[1] Investigations conducted in cooperation with the respective State experiment stations.

Rotations:
- Zanesville—Corn, wheat, meadow, meadow.
- Bethany—Corn, wheat, timothy and clover.
- LaCrosse—Corn, wheat, clover.
- Guthrie—Cotton, wheat, sweetclover.
- Statesville—Cotton, corn, wheat, lespedeza.

[2] Average for first- and-second-year meadow.

The effect of crop rotation in conserving soil and moisture often is not fully appreciated. Soil-improving crops such as the grasses and legumes permit less soil and water loss than small-grain and row crops during the time they occupy the land, as shown in table 2, and their residual effect reduces soil and water losses when the land is again cropped to row crops and small grain in the rotation. The effectiveness of crop rotation as compared with continuous cropping, in reducing soil and water losses is shown in table 3.

TABLE 3.—*Annual soil and water losses from corn and cotton grown continuously as compared to losses from corn and cotton grown in rotation. (Soil- and water and conservation experiment stations, Soil Conservation Service[1])*

Station and period	Crop	Rotation	Soil loss per acre	Savings per acre	Runoff as compared with precipitation	Savings as compared with precipitation
			Tons	*Tons*	*Percent*	*Percent*
Zanesville, Ohio, 1934-40.	Corn	Continuous	94.6		42.4	
	do	Corn, wheat, meadow, meadow.	42.7	51.9	24.8	17.6
LaCrosse, Wis., 1933-38	do	Continuous	111.8		28.7	
	do	Corn, wheat, clover	53.1	58.7	20.6	8.1
Bethany, Mo., 1931-40	do	Continuous	50.9		27.1	
	do	Corn, wheat, timothy, and clover.	18.8	32.1	19.7	7.4
Statesville, N. C., 1932-38.	Cotton	Continuous	33.9		12.1	
	do	Cotton, corn, wheat, lespedeza.	23.2	10.7	9.9	2.2
	do					
Guthrie, Okla., 1930-38	do	Continuous	18.9		12.5	
	do	Cotton, wheat, sweet-clover.	10.6	8.3	11.3	1.2

[1] Investigations conducted in cooperation with the respective State experiment stations.

In addition to the reduction of soil and water losses due to contour cultivation and the rotation, there is a further reduction due to the arrangement of crops in strips. If the grasses and legumes and other protective vegetation occupy entire slopes or fields, they protect only the land on which they are grown. When they are arranged in strips alternating with strips of intertilled crops, the protection they afford is extended to a considerable degree to the clean-tilled areas as well. Data showing the additional benefits of arranging crops in strips over that of contour cultivation and crop rotation alone in reducing soil and water losses are given in table 4.

TABLE 4.—*Annual soil and water losses from contoured and contour strip-cropped plots with different rotation at five soil- and water-conservation experiment stations, Soil Conservation Service, U. S. Department of Agriculture[1]*

Station and period	Slope	Width of strip	Rotation	Treatment	Runoff as compared with precipitation	Soil loss per acre
	Percent	*Feet*			*Percent*	*Tons*
Temple, Tex., 1939-40.	3		Cotton, oats and corn	Contoured	10.1	5.3
		36	do	Contoured and strip cropped.	7.3	1.6
State College, Pa., 1936-38.	9.38		Corn, wheat, timothy, and clover.	Contoured	9.9	12.1
			do	Contoured and strip cropped.	2.8	.5
			Corn, oats, timothy, and clover.	Contoured	10.1	15.0
		100	do	Contoured and strip cropped.	3.6	1.6
			Corn, oats, wheat, timothy and clover.	Contoured	8.1	5.0
		75	do	Contoured and strip cropped.	8.0	4.7
Arnot, N. Y., 1935-37.	8.15	311.2	Potatoes, oats, and clover, clover.	Up and down hill	5.3	5.2
		311.2	do	Contoured	1.8	.4
		103.6	do	Contoured and strip cropped.	.6	.05
Zanesville, Ohio, 1936-40.	14	80	Corn, wheat, meadow	Strip cropped	[2] 8.9	7.8
		70	Corn, wheat, meadow, meadow.	do	[2] 8.0	5.7

[1] Investigations conducted in cooperation with the respective State experiment stations.
[2] Inches of runoff.

Strips of perennial grasses and legumes between strips of intertilled crops and of small-grain crops provide the most effective crop arrangement. In areas where the percentage of grasses and legumes in the rotation is not sufficient for this arrangement of crops, meadow strips of perennial grasses and legumes not included in the regular rotation may often be used.

There is often greater runoff from small-grain strips than from intertilled-crop strips during the period of seedbed preparation and stand establishment due to the ridging effect of tillage and seeding implements used for small-grain and intertilled crops. For this reason, in humid regions, if the rotation makes it necessary for small-grain and intertilled crops to occupy adjacent strips, small-grain strips should be placed below the intertilled-crop strip for best results. Where strips of small-grain and intertilled crops must alternate because of lack of suitable perennial grasses and legumes for use in the rotation, terraces are usually needed with strip cropping.

In dry-farming areas, alternate strips of small-grain and intertilled crops, small grain and summer fallow, or two intertilled crops, one providing more cover and residues than the other, such as cotton and sorghum, or beans and sorghum are effective strip-covering arrangements to conserve soil and moisture. Where grasses and legumes can be grown, a meadow strip between the cultivated strips will often provide added protection. In many dry-land areas where the slopes are long and gentle, level terraces with strip cropping will conserve moisture, increase yields, and provide greater amounts of crop residues to prevent soil washing and drifting than strip cropping alone.

INCREASED YIELDS

When a strip-cropping system is established a number of changes usually are made in field and soil conditions that increase crop yields. In humid regions, lime is generally applied to get the legumes started in the rotation, and fertilizers are used on the small-grain and meadow seedings, and in both humid and dry-farming regions all field operations are changed from up and down hill to the contour. From experimental results with contour tillage, crop rotations, the use of lime, fertilizer, and other soil-building measures, it is known that the combination of all these measures and practices into a strip-cropping system improves the productivity of the soil. Farmers with strip-cropping experience report increased crop yields. Their conclusions are based largely on the amount of corn in the crib or grain in the bin or hay in the barn as compared with what they had before strip cropping was started. Such observations are not based on accurate measurements; nevertheless, coming from so many sources, they are significant.

In measuring the value of a soil conservation practice, the maintenance of crop yields at a moderate to high level is as important as immediate increases in crop yields. A series of studies are being made in Indiana, Iowa, and Missouri on the yield of corn in relation to the depth of topsoil. The first year's results from 16 fields at Fowler, Ind., in 1939, reported by R. E. Uhland in the 1940 Proceedings of the Soil Science Society of America, are summarized as follows: With 2 inches of topsoil, the average yield of corn was 36.8 bushels; with 3 inches, 46.1 bushels; with 4 to 5 inches, 51.8 bushels; with 6 to 7 inches, 59.8 bushels; with 8 to 9 inches, 62.2 bushels; with

10 to 11 inches, 68.6 bushels; and with 12 to 14 inches, 73.2 bushels. Data for 1940–41 from all three States are available. While the yields vary with the different conditions in the three States, the trend is the same. That is, regardless of the soil type and climatic and other conditions, the yield of corn decreases as the depth of topsoil decreases. From these data it can be concluded that if the topsoil is saved, the yield of crops will remain high. Therefore, by reducing erosion on cropland to a minimum with a strip-cropping system and terraces, where applicable, a rotation within the limits of the capability of the land, and soil-building measures in accordance with the needs of the soil, crop yields can be maintained. Also, if erosion is permitted to continue, it seems possible to foretell crop yields in the future with a certain degree of accuracy by the amount of topsoil. Where soil is eroding at the rate of one-fourth inch a year on cornland yielding 60 bushels an acre with 6 inches of topsoil, the corn yield may be expected to be reduced approximately one-half in one generation. Crop yields can be increased by proper soil-management measures, and these yields can be maintained permanently if the productive topsoil is held in place. Strip cropping is easy to install and is one of the most efficient conservation practices.

COST OF FARMING

Many farmers report savings in fuel consumption by farming on the contour. The extra power needed to pull farm equipment uphill can be used in contour farming to pull a heavier load or for greater speed, which results in more efficient operation. Tests conducted by the Kansas Agricultural Experiment Station at Hays, Kansas, on slopes of 6 to 8 percent showed the following fuel savings by contour farming: Moldboard plowing, 9.3 percent; disk plowing, 22.4 percent; disking stubble ground, 28.8 percent; disking plowed ground, 3.5 percent; and duckfoot cultivation 4.9 percent. They also showed that the time required for those operations, exclusive of turning, averaged about 10 percent less when done on the contour. Farmers using horsepower also find that it takes less power to farm on the contour. They report that it is easier on both teams and equipment, and frequently fewer horses are required for the same job.

Where field rearrangement has resulted in longer rows, many farmers have reported savings of 10 to 15 percent in the time required for farming operations. Some farmers, however, have reported increases in the time required because of point rows and sharp turns. In the major wheat-growing areas of the Great Plains and elsewhere, where large equipment is used on gentle slopes or on fairly level land that is wind strip cropped, the time and cost of farming may be slightly increased. Under these conditions, a change from large-block farming to strip farming often increases the amount of turning without the usual offsetting benefits from farming on the contour. Also, some grain may be lost in turning around the ends of strips and in finishing strips if the combine harvester is not fully loaded.

There is usually some expense involved in rearranging fields and in adjusting the cropping system when strip cropping is established. However, these are incidental to improvements. Most farmers who have experienced an increase in the cost of farming report that it is unimportant when compared with the benefits derived from the practice.

INSECTS AND HOT WINDS

Crop damage from chinchbugs can often be avoided by growing corn and meadow and small grain and meadow in alternating strips in separate fields. This arrangement of row crops and small grain by fields requires no special planning to avoid damage from chinchbugs since it eliminates bordering of corn and small grain and does not increase the difficulty of application of control measures where they may become necessary. This same grouping of crops lessens the likelihood of crop damage from hot winds. Also, where sorghums can be used to replace corn in the cropping system, the probability of damage from hot winds is much less.

Tillage and distribution of poison bait are the principal measures used in controlling grasshoppers on strip-cropped fields. Where infestations are local and small, baiting alone may provide adequate control. Whenever headlands, field borders, and buffer strips are sources of infestation, they should be baited early to kill grasshoppers before they migrate to adjoining crops. Small-grain stubble strips joining fallow strips to be seeded to winter wheat should be baited when necessary before the winter wheat is seeded. Where sorghums and wheat are both grown after fallow in the cropping system, an arrangement of crops by strips and fields so that sorghum strips alternate with the fallow strips to be seeded to winter wheat and the winter wheat strips alternate with fallow to be planted to sorghum reduces the likelihood of grasshopper damage.

Fall or early spring tillage of stubble strips will destroy many grasshopper eggs by exposing them to freezing and drying or by burying them so deeply that the hoppers cannot reach the surface after hatching. Tillage of stubble ground in the fall just before the egg-laying period has been found helpful also, as grasshoppers do not like a freshly tilled soil as a place for depositing their eggs. Where crop residues are needed on the surface to prevent erosion, the duckfoot, one-way, or a subsurface blade or shovel tillage implement should be used. When initial tillage of the strips to be fallowed is started after hoppers have hatched, working from the outside toward the middle will concentrate hoppers in the center of the strip, where they may be poisoned with a minimum of cost.

In eastern United States it has been found that strip-cropped fields have larger breeding populations of ground-nesting birds than comparable fields not strip-cropped. Thus, strip cropping may assist in the destruction of insects by increasing the population of insectivorous birds.

REGIONAL ADAPTATION OF STRIP CROPPING

Strip cropping is widely adapted in the United States, especially where perennial grasses and legumes are grown in crop rotations. Annual legumes, small grains and fallow, cotton and sorghum, and other crop combinations are used in certain areas. The method of application and use varies according to the erosion problems, the types of farming, and adapted crops.

NORTHEASTERN AND NORTH CENTRAL STATES

Strip cropping is well adapted to the northeastern part of the United States and to the upper Mississippi and Ohio River Valleys

because of the favorable climate, the productive soils, the type of topography, and the large number of crops that can be grown. Corn, sorghum, potatoes, soybeans, and tobacco are the principal intertilled crops grown. The small grains include both winter and spring varieties of wheat, rye, oats, and barley. The hay crops, which are so important in rotation, consist of annual, biennial, and perennial legumes, and of grasses. The list is long, but alfalfa, sweetclover, red clover, alsike clover, lespedeza, timothy, redtop, orchard grass, and bromegrass are some of the most common.

In the northern part of this area dairying, which requires large amounts of roughage, makes long rotations popular, including from 2 to 4 years of meadow. Crops may be arranged in fields so that the meadow crops can be grazed 1 or more years of the rotation. The following diagrams illustrate crop and field arrangements for three different rotations.

The 4-year rotation of corn and small grain and 2 years of meadow in a two-field arrangement with strip cropping can be used under a wide range of conditions but is particularly adapted to farms having a relatively small amount of cropland and a large amount of permanent pasture. The crops are arranged by strips in two equal-sized fields, as shown in figure 15. The first year in field 1 all A strips are in corn, while all B strips are in meadow; and in field 2 all A strips are in grain, while all B strips are in meadow. The second year in field 1 the A strips are all in grain and the B strips in meadow, and in field 2 all A strips are in meadow and the B strips in corn. The third year in field 1 the A strips are meadow and the B strips corn, and in field 2 A strips are in meadow and the B strips in grain. The fourth year in field 1 the A strips are in meadow, and B strips in grain, and in field 2 A strips are in corn and B strips in meadow. This completes the 4 years of the rotation, and the fifth year the rotation starts all over again (figs. 16 and 17). The field having alternate hay and grain strips can be grazed each year after the grain is harvested and the first cutting of hay is removed. This aftermath provides late-summer feed when permanent pastures are dormant and in need of protection. The pastures provide feed again as soon as they are revived by fall rains and cool weather, when the new seedings in the grain strips need protection.

The 6-year rotation, corn, small grain, and 4 years of meadow in three equal-sized fields or field units with contour strips, can be used to advantage on farms with little or no permanent pasture. Each year the crop arrangement for this rotation, as shown in figure 18, is the same for two of the three fields as for the 4-year rotation, while both the A and B strips in the third field are in meadow. This field can be used for rotation pasture while the hay for winter roughage is grown on strips in the other two fields. For example, the first year, field 3 is all in meadow, while fields 1 and 2 are growing second- and third-year meadow for winter hay. The second year of the rotation, field 2 can be used for pasture, the third year, field 1 and so on; each field being grazed once each 3-year period, or twice during each complete turn of the rotation (fig. 19).

This rotation and field arrangement affords the greatest vegetative control of erosion that can be provided for cropland. The contour strips reduce the amount of slope in intertilled or grain crops. The alternate strips of meadow tend to spread and slow down the

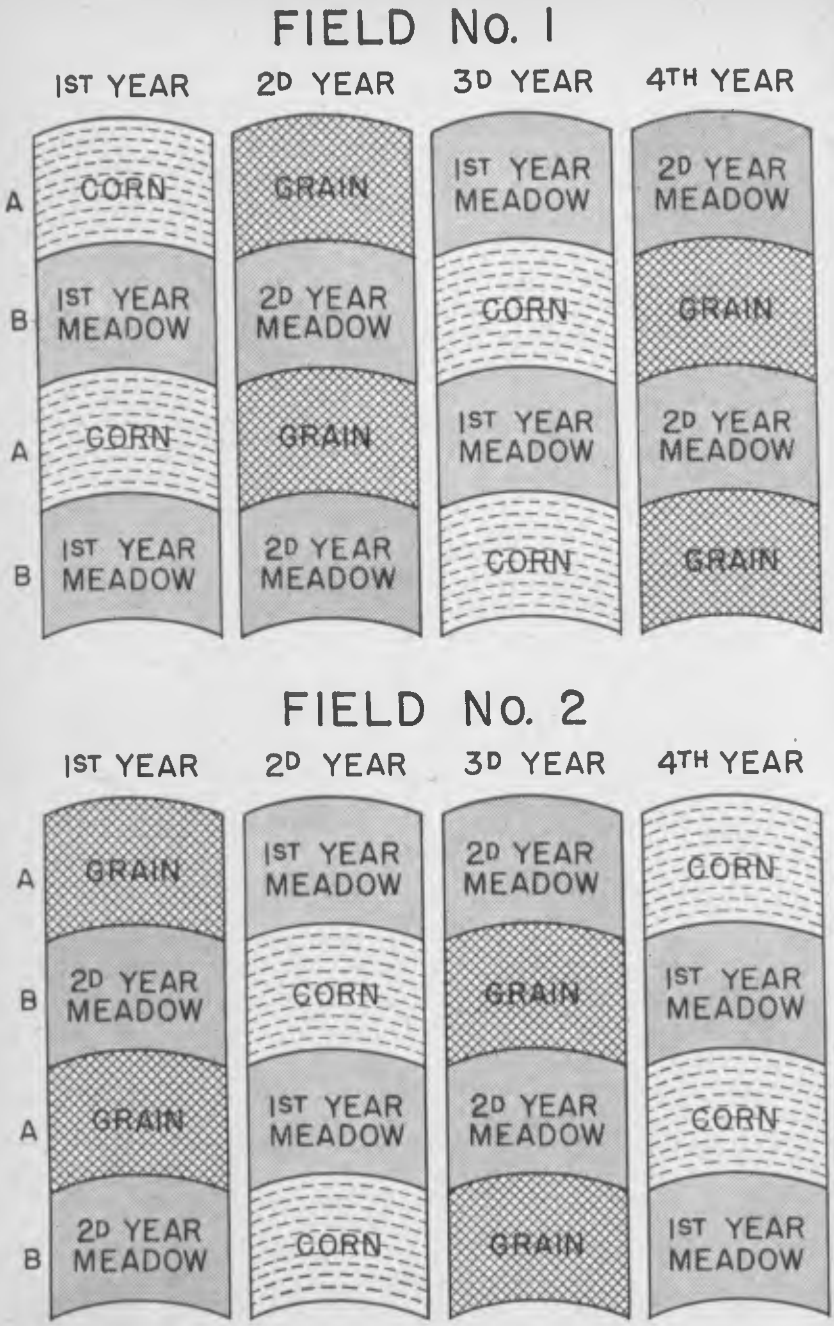

FIGURE 15.—A 4-year rotation of corn, grain, meadow, meadow, by strips in a 2-field arrangement. Each year alternate strips are in corn and meadow in one field and grain and meadow in the other

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FIGURE 16.—Alternating strips of small grain and meadow in a contour strip-cropping system.

runoff water, forcing it to deposit any silt load and permitting more time for water to soak into the ground. The 4 years of meadow builds up organic matter and a granular structure in the soil that increases the water-absorbing capacity. By having a meadow grazed

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FIGURE 17.—Alternating strips of corn and meadow in a contour strip-cropping system on an Ohio farm.

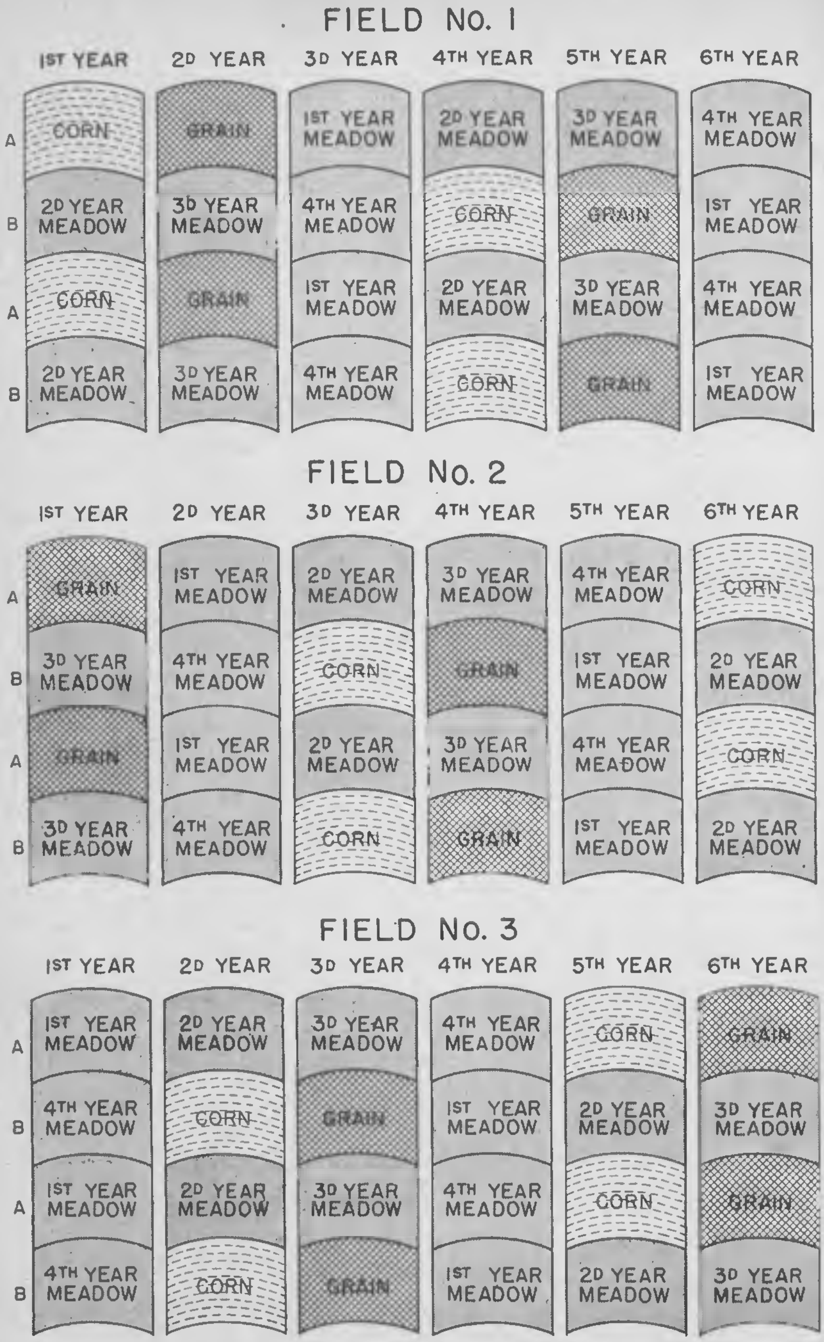

FIGURE 18.—A 6-year rotation of corn, grain, and 4 years of meadow by strips in a 3-field arrangement. Each year alternate strips are in corn and second-year meadow in one field, grain and third-year meadow in a second field, and first- and fourth-year meadow in the other field.

once each 3 years (first- and 4-year meadow), less plant food is lost from the field than if the crop is removed for hay.

On many farms it is difficult to arrange three equal-sized fields or field units. It often is more practical to divide the cropland into three fields, one of which is only half as large as either of the other two. Such a field arrangement lends itself to a 5-year rotation of corn, grain, and 3 years of meadow in contour strips in the two large fields, as shown in figure 20. This field arrangement has all of the advantages of the 6-year rotation in three equal-sized fields (diagram 2) except the advantages of 4 years of meadow over 3 years of meadow.

With this field arrangement and 5-year crop rotation (fig. 20) field number 3 could be grazed 3 out of the 5 years of the rotation

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FIGURE 19.—Dairy cows grazing on a meadow field. Alternating strips of oats and meadow and corn and meadow in two fields in the background.

since it is not strip cropped and the entire field is in meadow. The crops in the two large fields rotate in much the same manner as for the 4- to 6-year rotations and are grazed only once in each rotation, the first year field number 2, and the second year field number 1. It may be necessary to use buffer strips or terraces in field 3 when it is planted to corn or grain if erosion cannot be controlled by the rotation alone.

Not all farms can be planned in a strip-cropping system which provides for rotation pastures, but there are so many variations to these general plans outlined here that some modification can usually be worked out for the farms with peculiar conditions.

One of the difficulties farmers experience in starting a rotation is the loss of meadow seedings due sometimes to unfavorable weather conditions, but usually to lack of lime, low fertility, poor seedbed

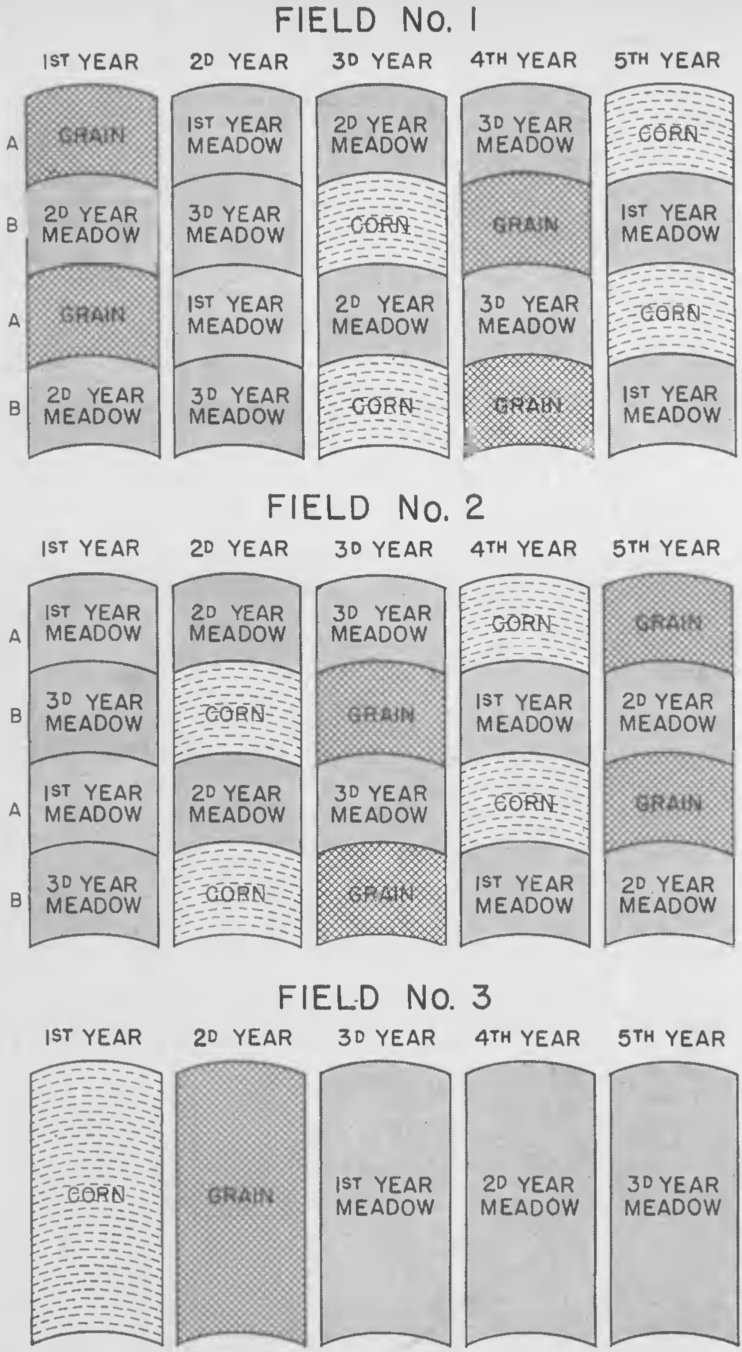

FIGURE 20.—A 5-year rotation of corn, grain, and 3 years of meadow in a three-field arrangement with strip cropping in the two large fields and one small field.

preparation, or a combination of these and other factors. If this happens in a strip-cropping system with field arrangements just described, strips affected can be reseeded without the loss of one meadow year seriously affecting the other strips or crops in the strip-cropping system. The advisability of pasturing strips in first-year meadow is often raised, but the farmers who are doing it experience no difficulty when such strict grazing regulations are observed as (1) keeping stock off fields that are too wet and soft and (2) avoiding late and too-close grazing.

In parts of the Corn Belt, where less roughage is desired, rotations containing 1 or 2 years of one or both corn and grain and from 1 to 3 years of meadow are in use. As a rule, soils are more productive, slopes are more gentle, and erosion is not as severe as in the dairying sections. More intertilled and grain crops can be included in the rotation without soil deterioration. Yields of these crops can be increased in a strip-cropping system because of a reduction in soil and water losses, additions in soil-organic matter, and a general improvement brought about by the soil-building measures.

On Corn Belt farms where livestock is kept and there is a need to graze the small-grain stubble and second-year sweetclover, the crops may be arranged by strips and in separate fields with perennial grass and legume buffer strips. For example, a 4-year rotation of corn, corn, grain, and sweetclover, may be arranged by strips in four equal-sized fields, or field units, as shown in figure 21. Each year two fields are in corn, one field is in grain and one field is in sweetclover, with all cultivated strips alternating with perennial grass and legume buffer strips. The first year, fields 1 and 2 are in corn, field 3 is in grain, and field 4 is in sweetclover; the second year, fields 1 and 4 are in corn, field 2 is in grain, and field 3 is in sweetclover; the third year, fields 3 and 4 are in corn, field 1 is in grain, and field 2 is in sweetclover; and the fourth year, fields 2 and 3 are in corn, field 4 is in grain, and field 1 is in sweetclover. By this arrangement of crops in strips in separate fields, the second-year sweetclover can be grazed. Also, the small-grain stubble with first-year sweetclover can be grazed after the small grain is harvested. The buffer strips are grazed with the second-year sweetclover and with the small-grain stubble after small-grain harvest. The year fields are in corn, the buffer strips are harvested for hay, and one cutting of hay may be had the year the field is in small grain. Some of the land in the Corn Belt does not need supporting conservation practices; therefore, strip cropping does not have the general application found in some other areas.

Where tobacco and potatoes are used in the rotation as the intertilled crop instead of or in addition to corn, special modifications in field arrangements must be made. Drainage is of special importance for both crops. Often the rows or strips are given a slight grade to prevent impounding too much water. Even-width strips are desirable, but if strips are irregular in width the point rows should be arranged on the lower edge so that the adjoining strip can be used for turning farm equipment. Strip cropping alone may not furnish sufficient protection against erosion. Terraces, in addition to the strip-cropping system, provide a means of draining off excess water as well as reducing soil losses.

Wind erosion occurs in the Northeast and the upper Mississippi Valley and near the Great Lakes but not to the extent that it occurs in some other parts of the United States. It is almost always con-

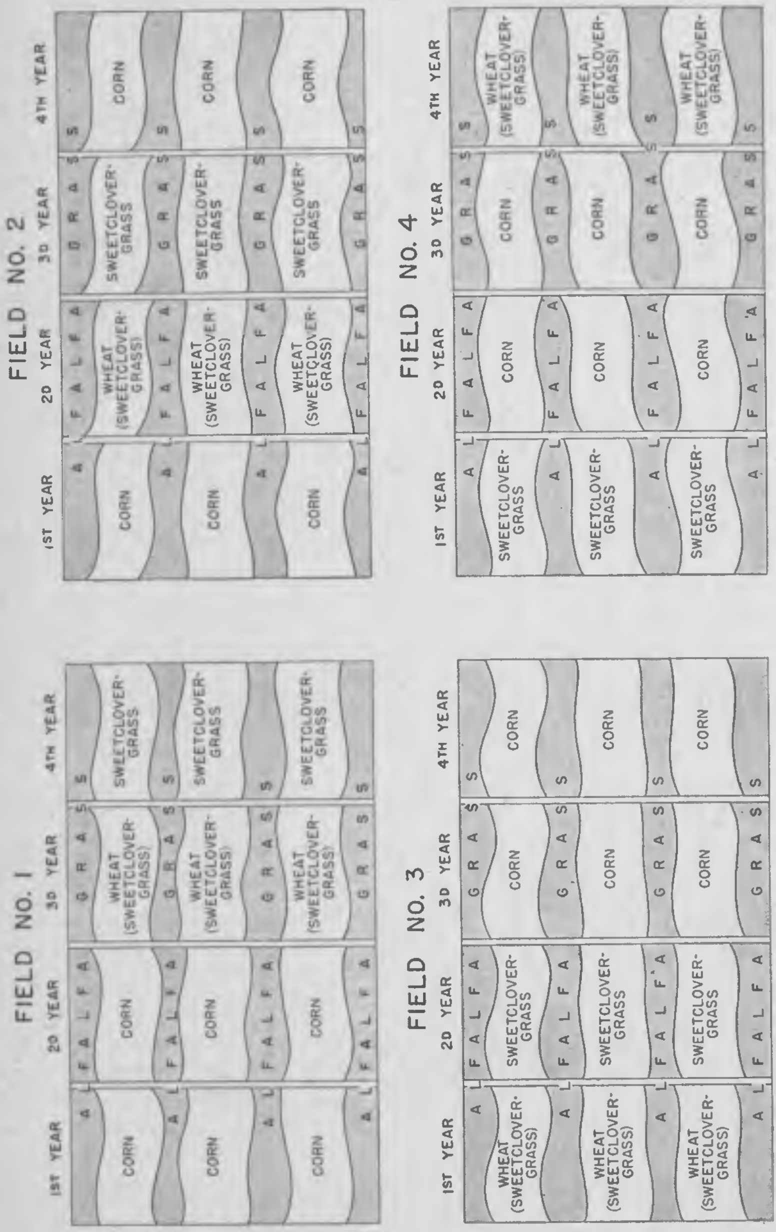

FIGURE 21.—A 4-year rotation of corn, corn, grain, and sweetclover by strips in a 4-field arrangement and supported by perennial grass and legume buffer strips. Each year 2 fields are in corn, 1 in grain, and 1 in sweetclover.

fined to relatively small areas of sandy to sandy loam soils or to muck lands. The latter are generally used for the production of truck and other crops with such high value per acre that they can be protected by windbreaks and by cover crops.

The sand and sandy soils present the most difficult problems in the control of soil drifting. In severe windstorms the air may be filled with dust and the entire field affected by soil drifting. But real damage is done by the sharp sand particles that are rolled and bumped along close to the surface of the ground and that rasp the stems of plants until they are badly damaged or cut off completely.

Strip cropping is effective in preventing soil drifting, especially where 3 years of perennial vegetation can be used in the rotation. Windbreaks of woody vegetation give additional protection. Since the heaviest damage is likely to occur in the spring and fall, winter grain, where adapted, can be used to advantage as a cover crop. Intertilled crops are subject to the greatest damage. It is always advisable to arrange the rotation of strips so as to have a meadow strip on the windward side of the cultivated strips. Rough cultivation in the strips across the direction of the prevailing wind is beneficial. Rotations and field arrangement of crops in the strip-cropping system must be worked out for each local condition.

The extreme southern part of the midwest area is somewhat handicapped by the number of crops that can be grown profitably, and so the rotations and methods of strip cropping are decidedly different from those a little to the north. Korean lespedeza is a popular legume grown in an annual rotation with winter small grains where soils are acid and the level of fertility has been lowered by erosion and too-intensive cropping in the past. Annual lespedeza is also used in rotations that include cotton and corn. Deeper rooted legumes are used on soils which have been limed to provide sufficient calcium and to reduce acidity. Usually such rotations are by fields supported by terraces or buffer strips rather than in a contour strip-cropping system.

SOUTHEASTERN AND WEST GULF STATES

Strip cropping in the southeastern and west Gulf region (including Arkansas and Oklahoma) is generally accepted as an effective soil conservation practice, although there is a wide difference in the methods used in the various specialized cropping areas. The soils are old and low in fertility over much of the area; the seasons are long; the principal crops grown offer little resistance to erosion and the continuous production of one crop is common practice. These are some of the factors that have led to the loss of so much of the productive topsoil.

In the Southeast, cotton, corn, tobacco, peanuts, and sorghums are the principal intertilled crops grown, and oats, rye, barley, and wheat the principal grain crops. In addition, there are several annual legumes grown, such as annual lespedezas, vetch, Austrian Winter peas, soybeans, cowpeas, crimson clover, crotalaria, and others, and perennial legumes, such as sericea lespedeza, kudzu, and alfalfa. Rotations have not been followed extensively in the past; in fact, kudzu, sericea, crotalaria, and some of the other soil-building crops have only recently come into extensive use. Strip cropping is one of the best means of getting definite rotations of intertilled, grain, and legume crops established. Under average farm conditions, fields vary so much in size that rotation by fields is difficult.

On cotton farms commonly used rotations include (1) a 4-year rotation of cotton, cotton, or corn, 2 years of grain with lespedeza,

with a winter legume between the 2 years of intertilled crops; (2) a 3-year rotation of cotton, corn, and small grain followed by a summer hay crop; and (3) a 2-year rotation of cotton followed by a winter legume crop and corn interplanted with a summer legume. Usually the 4-year and the 3-year rotations are used on the steeper slopes and the 2-year rotation on the more level land (fig. 22). The rotations include a high percentage of intertilled crops, but by using winter cover and green-manure crops, soil organic matter can be maintained from year to year. Where tobacco is grown in rotation, a 4-year rotation of tobacco 2 years, small grain 1 year, and meadow (usually redtop) 1 year, is common.

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FIGURE 22.—Alternate strips of oats and lespedeza, and cotton in a 4-year rotation of cotton (winter cover), cotton, oats and lespedeza, and lespedeza, on a North Carolina farm.

A large part of the strip cropping on cotton and tobacco farms in the Southeast is done on terraced land, and generally the terraces form the boundaries of the strips (fig. 23). Such an arrangement provides permanent strip boundaries and simplifies the operation of a rotation in strips. On the steeper slopes, where tobacco is grown, buffer strips of grasses 12 to 18 feet wide are often seeded above the terraces to reduce silting in the terrace channels.

In sections where terracing is not needed, the width of strips varies from about 60 to 150 feet, depending on the steepness and length of slope, degree of erosion, and other factors. Often the steep, badly eroded portions of the slopes in crop fields are planted to kudzu or sericea lespedeza to provide permanent protection or strips may be designed to be cropped in rotation with corn (fig. 24). The use of kudzu or sericea in rotation with corn on these steep, badly eroded slopes is proving very successful. Corn yields are increased

SC-1065

FIGURE 23.—Contour strip cropping on terraced land in South Carolina.

approximately fourfold, kudzu or sericea provides a source of hay, and erosion is controlled. Kudzu in a 2-year rotation with corn will reestablish itself in the corn by fall, provided cultivation of the corn

ALA-10205A

FIGURE 24.—The steep portion of the slope on this Alabama farm is in kudzu, while the gentle portions of the slopes above and below the kudzu strips are cropped to a rotation of row crop, small grain, and annual legumes.

is done so as to leave as many kudzu plants as possible. Where kudzu is to be harvested for hay, it will be necessary to extend the rotation to 3 or more years in length. Where sericea is used, it is necessary to reseed to establish stands (fig. 25). With a rotation of corn and kudzu or sericea on the steeper portions of the slopes, a rotation of cotton, small grain, and annual lespedeza or crotalaria may be used on the gentle slopes. If the portion of the slope above or below the perennial rotation strips is of sufficient size to require division, the rotation of annual crops may be arranged in strips.

In the western Gulf region, strip cropping is generally combined with terracing. Lack of suitable perennial crops for use in rotation is rather general and is perhaps the greatest factor limiting

ALA'D2-63

FIGURE 25.—A crop of corn following sericea lespedeza on an Alabama farm.

the wider and more effective use of strip cropping as a conservation practice.

In the rolling Coastal Plains of eastern Texas, southeastern Oklahoma, southern Arkansas and Louisiana, cotton, corn, potatoes, sorghum, and small grain are the principal field crops grown. These crops may be grown with summer and winter legumes in a strip-cropping arrangement to facilitate contour operations and proper rotation of crops. Because of the high percentage of intertilled crops and the lack of perennial grasses and legumes in the rotation, the strip-cropping system will usually need to be supported by terraces. However, strip cropping is often advisable before terracing as a means of extending the terracing season. When it is done with this objective, the oat strips are located on terrace lines so that the terraces may be constructed during the summer after the oats are harvested. The fields may be divided along terrace lines

into as many strips as there are crops in the rotation, or some multiple of the number of crops.

The rotations usually include a cash crop and a feed crop with summer and winter legumes for cover and green manure. A 2-year rotation may consist of cotton the first year, followed by oats and vetch for winter cover and soil improvement; and corn the second year, again followed by a winter-cover and green-manure crop. The corn may be interplanted with cowpeas, or velvetbeans, or may be replaced by sorghum. A 3-year rotation may consist of fall-sown small grains for feed, or grazing, followed by cowpeas or soybeans cut for hay or plowed under as green manure for soil improvement, the first year; hairy vetch or other winter legumes or small grain for winter cover and green manure, followed by cotton the second year;

OKLA-8008

FIGURE 26.—Little bluestem in a contour strip-cropping system on an Oklahoma farm.

and a winter cover crop of vetch, bur-clover or small grain, followed by corn interplanted with cowpeas or velvetbeans the third year.

Kudzu and sericea lespedeza are becoming more popular in the Coastal Plains and, where they are adapted, should greatly improve the effectiveness of strip-cropping systems. These crops may be planted in contour strips with the areas above and below farmed to a rotation of annual crops. Generally strips of kudzu or sericea should not be less than 50 feet in width, and they should be rotated over the cultivated land.

In eastern Louisiana and Arkansas, eastern Oklahoma, and northern Arkansas, the annual lespedezas are well adapted and may be grown in rotations with small grain, cotton, corn, and other adapted crops in a strip-cropping arrangement. Sericea is well adapted in

parts of this area also, and on the limestone soils, red clover, alfalfa, timothy, and orchard grass grow well. Where these crops are grown in the rotation, the strip-cropping system is more effective than where only annual crops are used. In northeastern Oklahoma, meadow strips of little bluestem and other native grasses are proving well adapted for use in strip-cropping systems (fig. 26). Since the bluestems are slow to become established, it is generally advisable to leave the meadow strips for several years before rotating them to another part of the field.

In the Blacklands and Grande Prairie sections, where the slopes are long, fairly uniform, and gentle, strip cropping usually should be combined with terracing. The prevalence of cotton root rot prevents the use of alfalfa and biennial sweetclover in rotations and

FIGURE 27.—A terraced and strip-cropped field in the Blacklands of Texas.

limits the crops adapted to growing in strips with cotton and corn to the small grains, sorghum, and Hubam clover. The strip-cropping rotation may consist of cotton, cotton, oats and Hubam clover, and corn. Winter oats are seeded in the fall, and Hubam clover is seeded in the oats during the fall or winter. The clover is turned under the succeeding fall or winter, and corn is planted the next spring (fig. 27). While this arrangement of crops in strips will reduce soil and water losses materially, on most slopes there is usually sufficient concentration of runoff to cause gullying unless the fields are terraced. On slopes that are not in need of terraces, the same rotation may be arranged in contour strips and supported with meadow buffer strips of bluestem and other native grasses. Strips of bluestem are used also to stabilize badly eroded areas, including eroded chalky and seepy areas.

On the loose, sandy soils in the West Cross Timbers area, strip cropping is adapted to both wind and water erosion control. Where runoff occurs, the strips should be placed on the contour to conserve moisture. The strips must be narrow to be effective. Farmers find that strips consisting of four rows of sorghum or Sudan grass alternating with eight rows of peanuts prove fairly effective in controlling soil drifting (fig. 28). The sorghum strips should be left undisturbed until the land is prepared for another crop in order that sorghum residues may protect the land through the winter and early spring. Rye or some other small grain may be sown on the peanut strips after harvest to provide cover. Since the amount of fall growth is the deciding factor in the value of the winter cover crop, seedings

TEX–40522

FIGURE 28.—Peanuts and sorghum grown in alternate contour strips on a farm in the west Cross Timber area of Texas.

should be made as soon after harvest as possible, provided moisture is available. In the rolling plains area of western Texas and Oklahoma strip cropping for wind and water erosion control is applied in the same manner as in the southern High Plains which is discussed on pages 39 to 42.

THE GREAT PLAINS

Contour strip cropping, wind strip cropping, and buffer strip cropping are used in the Great Plains for wind- and water-erosion control and for moisture conservation. Where runoff occurs in sufficient amount to cause soil washing or to be important in relation to crop yields, contour strip cropping should be used. The moisture conserved by contour cultivation increases crop yields in many parts of the region and in so doing provides greater amounts of crop residue for protection of the soil against wind erosion. While contour strips

cannot always be crosswise to prevailing winds, there is usually sufficient change in direction of the strips to prevent the wind from getting a long sweep over unprotected ground. In some areas of the Great Plains, erosive winds are likely to come from any direction, in which case strips on the contour may provide more effective control than strips laid crosswise to the prevailing winds. Wind strip cropping is well adapted where rainfall is limited, the topography relatively level or undulating, and the soils are sandy. Under these conditions runoff is so slight as to be unimportant.

In the northern Great Plains, where wheat is grown after summer fallow, wind strip cropping, or strip farming as it is sometimes called, is used extensively. However, contour strip cropping is replacing wind strip cropping in areas where moisture conserved by contour

FIGURE 29.—Corn and small grain in alternate strips on the Plains of Wyoming.

farming increases yields. Where wheat is grown in alternate years with fallow, the strip-cropping system may consist of alternate strips of wheat and fallow, or the strips may be separated by buffer strips of grass for hay. The grass strips provide permanent strip boundaries, as well as add to the effectiveness of the system for erosion control. When 2 years of wheat are grown after fallow, every third cultivated strip is in fallow, wheat after fallow, or wheat after wheat. From experience, farmers have found that strips may vary in width from about 5 rods on sandy soils to 20 rods on the heavy soils. When the strips are on the contour, the grassed buffer strip should include the irregular areas so that the cultivated strips may be uniform in width and easily worked with large equipment. Where stubble ground should be worked after harvest to kill weeds and conserve moisture, the tillage should be done with a subsurface tiller that leaves the stubble upright to hold snow and to protect the fallow strips during

the winter and spring months when soil drifting is most likely to occur. Summer tillage on the fallow strips should leave the surface of the ground cloddy and mulched with crop residues to conserve moisture and prevent erosion. Many farmers are now using the plow with moldboards removed, one-way, duck-foot, rotary-rod weeder, and blade and shovel implements for fallow operations which leave all or a large portion of the crop residues on the surface.

In parts of the northern Great Plains, strip cropping with alternate strips of small grain and corn or sorghum is frequently practiced (fig. 29). Strips of small grain alternating with strips of intertilled crops do not provide much protection during the spring after the row-crop stubble strips have been disked and planted to small grain and the small grain stubble strips have been prepared for corn. This disadvantage may be overcome by having strips of grass and legume meadows between the cultivated strips. Crested wheatgrass, western wheatgrass, bromegrass, alfalfa, and sweetclover in mixtures, where adapted, are suitable for such use. The meadow strips can be shifted when desired, and rotated over the farm. When the strips are on the contour, all irregularities in the width of strips may be seeded to meadow so that uniform-width strips are available for annual crops. Where sweetclover is grown regularly in the rotation, the strip-cropping system may include strips of small grain, row crops, and sweetclover. On sandy land subject to severe wind erosion, a rotation including corn, rye, and sweetclover is well adapted, and if crop residues are used as mulch the rotation provides a fairly continuous cover for the land.

Buffer strips of perennial grasses, of annual row crops, or of perennial shrubs are used to a limited extent for wind-erosion control. On farms where small grains are grown more or less continuously the buffer strips of grasses and legumes provide a guide for contour operations and may occupy the irregular areas between contour strips (fig. 30). Generally, buffer strips of grasses and legumes may be used to advantage wherever it is desirable to have the cultivated contour strips uniform in width. Buffer strips of corn 4 to 10 rows wide, planted at intervals across potato fields and fields in summer fallow have proved helpful in controlling erosion and in holding snow on the land during the winter (fig. 31). Shrub buffer strips are being tried in many parts of the northern Great Plains and, where adapted, have the advantage of being permanent. Also, tree shelterbelts add to the effectiveness of strip cropping, in preventing soil drifting.

In the southern Great Plains, where summer fallow is practiced in connection with winter wheat production, a cropping system which includes contour strips of wheat and fallow, sorghum and fallow, or wheat, fallow, and sorghum greatly reduces erosion hazards. In general, strips should not exceed 250 feet in width (fig. 32). Where sorghums are included in the rotation, an abundance of sorghum residue should be left on the land for protection against erosion and to add organic matter to the soil. For these reasons, grain sorghums from which only the grain is harvested will usually provide more effective control than forage sorghums. When forage sorghums are grown, they should be harvested to leave at least a 12-inch stubble.

Summer-fallow operations are usually not started until after the danger of wind erosion is past in the spring, and consequently the

MONT-5235B

FIGURE 30.—Grass buffer strips between uniform-width contour strips of small grain on a Montana farm.

strips in wheat stubble and sorghum stalks provide protection to the strip of fall-seeded wheat during the blow season. When wheat fails to become established on summer-fallow strips, sorghums should be

ND-348

FIGURE 31.—A buffer strip of corn holds snow in this North Dakota field.

planted to avoid 2 successive years in fallow. The original strip-crop pattern should be resumed at the first opportunity.

Generally in strip cropping terraced fields, each strip of fallow, wheat, and sorghum occupies the interval between two adjacent terraces. Some farmers prefer to plant the terrace ridges continuously to sorghum because of unfavorable moisture conditions for the production of wheat.

Cotton provides little resistance to wind erosion, and severe soil blowing frequently occurs where cotton is grown in large fields. In the high plains and rolling plains of western Texas and western Oklahoma, growing cotton in strips alternating with strips of sorghum or Sudan grass greatly reduced wind erosion (fig. 33). In general, farmers find that cotton strips should not exceed 150 feet in width and

KANS-264

FIGURE 32.—Harvesting wheat on a contour strip-cropped field in western Kansas.

the sorghum strip should not be less than 50 feet wide. The width of strips should be arranged so that by shifting sorghum strips each year, cotton will not follow cotton more than 2 years in succession. Frequent narrow strips of sorghum are more effective than wide strips spaced farther apart.

In portions of eastern Colorado and New Mexico where beans are grown on dry land, wind erosion is a serious problem. The methods of harvesting beans remove practically all crop residue, leaving the soil unprotected from wind and water erosion during the winter and early spring months. Contour strip cropping with beans alternating with sorghum or broomcorn is the most effective crop arrangement. Only the sorghum grain or broomcorn brush should be harvested. Spring-seeded oats or barley may be used instead of sorghums or broomcorn, but the small grain generally provides less

effective control. Small grains, if grown, should be harvested with a combine, so as to leave the maximum amount of crop residue to protect the soil against erosion. Farmers' experience has been that bean strips should not exceed 50 feet in width and that the crops should rotate each year so that beans will not occupy the land 2 years in succession.

On very sandy soils, in areas where forage sorghums are the principal crops grown on the farm, the sorghum stubble is frequently inadequate to protect the soil against wind erosion. Under these conditions farmers find that growing forage sorghums and grain sorghums, or broomcorn, in alternate strips, is helpful in controlling erosion.

TEX-989

FIGURE 33.—Cotton and sorghum grown in alternate strips on the contour for moisture conservation and prevention of soil drifting on the high plains of Texas.

THE FAR WEST

As considered here, the far West includes the area from the Rocky Mountains west to the Pacific coast. It is an area in which strip cropping is used only to a very limited extent. Some of the factors which limit the use of strip cropping in this region are: (1) Much of the farm land is irrigated and on this land strip cropping is not adapted; (2) many areas receive very little rainfall during the summer, when crops are grown, and entire fields may be protected during the winter rainfall season by tillage, crop residues, and cover crops; (3) in some of the low-rainfall areas, stands of perennial crops are not sufficiently dense to spread runoff effectively from higher lying cultivated strips; and (4) in parts of the region, the steep and irregular slopes and the large equipment used in farming operations makes farming in strips difficult. However, in spite of these general limitations, strip cropping has found local adaptation in parts of the far West.

On the grain lands of the Pacific Northwest and the Great Basin, where water erosion occurs, strip cropping to facilitate crop rotations and contour cultivation is proving practical and effective in the erosion-control program. Because of the uneven and steep slopes, contour strip cropping is not always practical, and modifications of field strip cropping to fit the physical conditions must be used.

In the Palouse area, where the slopes are short, the eroded hilltops may be seeded to perennial grasses and legumes and the remainder of the slope farmed as one or two fields, approximately on the contour, with grasses and legumes occurring frequently in the rotation (fig. 34).

The hilltops and steep north slopes should be kept in alfalfa and grass and plowed only to renew stands. The alfalfa and grass stands

IDA-10011

FIGURE 34.—The hilltop and waterway in grasses and legumes meadow and the lower slopes in cultivation on a Palouse farm.

will remain productive from 4 to 6 years, or longer, depending on the soil and climatic conditions. Frequently it is advisable to grow 1 or 2 years of small grain before reseeding. Where the hilltops are severely eroded, growing a crop of sweetclover previous to seeding the longer lived alfalfa and grass mixtures improves the soil and results in better stands and higher yields of forage. On the slopes more intensive rotations may be used. Sweetclover and grass, and alfalfa and grass are well adapted as the soil-building crops in rotations including small grain, peas, and fallow. The choice and sequence of crops will depend on the class of land and the type of farm, whether cash crop or livestock. The sweetclover and grass mixture may be utilized for green manure, pasture, or hay. When seeded without a companion crop the first year's growth of sweetclover and grass provides excellent pasture during the late summer when other pastures are dry.

In the Blue Mountain area, where the slopes are long, diversion terraces may be used with strip cropping to shorten the length of slope. The width of strip usually conforms with the terrace interval. Alfalfa-grass and sweetclover-grass mixtures are well adapted for use in various rotations, including grain, peas, and fallow.

The diversion terraces should be seeded to a mixture of alfalfa and adapted grasses. Usually the seeding should extend 20 to 30 feet above the terrace channel so that it may serve as a filter strip to prevent silting of the terrace channel. Perennial grasses and legumes should be established in all drainageways and terrace outlets to prevent gullying.

COLO–10417

FIGURE 35.—Strips of beans and sorghum on a terraced field in southwestern Colorado.

Strip cropping may prove a means of water erosion control also on the wheatlands of the Columbia River Basin, although its value under these conditions has not been thoroughly demonstrated. In the Great Basin area alternate strips of wheat and fallow, supported, where needed, by buffer strips of perennial grasses and diversion terraces, show promise.

In the grain-fallow areas of the far West strip cropping to prevent soil drifting is not generally required if crop residues are properly utilized. Tillage that leaves the stubble on the surface of the ground and provides a rough, open surface condition during the winter, usually gives adequate protection without strip cropping.

In the pinto bean districts of the Southwest, strip cropping is used effectively in the control of soil drifting. Where the land is subject to both wind and water erosion, contour strip cropping should be used

and generally should be combined with terracing. Contour cultivation and terraces will prevent soil washing and conserve moisture, while strip cropping will prevent soil drifting. Wind strip cropping should be used only where the soil type and the slopes are such that runoff is so slight as to be unimportant.

The strip-cropping system usually consists of bean strips, from 100 to 150 feet in width, alternating with strips of corn, sorghum, Sudan grass, or small grain (fig. 35). Terraces usually form the boundaries of the strips when used with a strip-cropping system. Frequently, a buffer type of strip cropping is used, in which case only the terrace ridge is seeded to sorghum, Sudan grass, or small grain.

NM-9493

FIGURE 36.—Contour listing beanfields in the fall prevents soil drifting, catches and holds snow, and prevents runoff.

The residues from the bean crop are usually inadequate to prevent erosion during the winter. Rough tillage, such as blank listing, is always advisable to control erosion during this period. The lister furrows hold snow on the fields and prevent melting snows and winter rains from running off (fig. 36). Diversion terraces should be used, where needed, to protect fields against runoff from higher lying land.

A few farmers have practiced strip cropping in parts of California and elsewhere in the diversified-farming areas on the Pacific coast. The need of increased roughage on most of the diversified livestock farms in these areas offers opportunities whereby rotations may be arranged in a strip-cropping system to control erosion. However, its value and limitations under these conditions have not been determined.

SUMMARY

Strip cropping is an old conservation practice. Little was known about it in this country until the U. S. Department of Agriculture, through the Soil Conservation Service, tested its value in thousands of farm demonstrations. Farmers in soil conservation districts all over the United States are adopting it as one of the easiest ways to hold soil in place, conserve moisture and increase crop yields.

Strip cropping on the exact contour is the most effective method of strip cropping to conserve soil and moisture; however, modifications from the true contour give less satisfactory results. Strips in straight parallel bands crosswise to prevailing winds aids in preventing serious soil drifting.

Strip cropping breaks the length of slope or expanse of clean-tilled area by bands of intertilled grain and forage crops. It conserves soil and moisture and increases crop yields by providing for the operation of all farm equipment on the contour, for grassed waterways, and for soil-improving measures such as rotations, in line with the capability of the land; for lime and fertilizer where needed, for green manure and cover crops; for stubble mulch; and for other soil-improvement practices. Its effectiveness depends on how well these measures and practices are established and maintained.

Strip cropping in alternate bands of intertilled and meadow crops and of grain and meadow crops provides the greatest vegetative control for cropland. Such a system can be arranged in either two or three fields or units, depending on the number of years of meadow in the rotation.

Strip cropping in different localities takes on various field patterns. It is well adapted to humid, rolling areas where grasses and legumes are grown and where large amounts of roughage are required for livestock, and in dry-land areas where summer fallow is practiced, and where row crops are grown extensively in the cropping system. Some specialized cropping areas have been slow to adopt the practice.

Strip-cropping methods and uses are described in this bulletin by four regions in the United States—(1) the Northeast and North Central, (2) the Southeast and Western Gulf, (3) The Great Plains, and (4) the far West.

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